

**Establishment of an Enhanced Long-term Groundwater
and Stream Flow Monitoring System
in Hopewell Township, Mercer County, New Jersey**

Final Report

**A joint project of Hopewell Township and
United States Geological Survey**

**Developed with the assistance of Hopewell Township,
the Delaware River Greenway Partnership,
and the National Park Service
through the National Wild and Scenic River Management Program**

prepared by

**Michael Aucott, Hopewell Township Environmental Commission and
Glen Carleton, United States Geological Survey**

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Summary

A system to observe any trends in surface water and ground water quantity has been set up in Hopewell Township, Mercer County, NJ under the supervision of the United States Geological Survey (USGS). Funding for the project was provided by Hopewell Township and a grant from the Delaware River Greenway Partnership (DRGP) operating in conjunction with the National Park Service through the National Wild and Scenic River Management Program.

The system includes three ground water level monitoring wells equipped with electronic data loggers, and six stainless steel V-notch weir low-flow stream gauges as specified by the scope of work for the grant from the DRGP. Three more low-flow gauges are partially complete and will be completed next year using Township resources. Initial data collection, quality assurance and quality control, and posting of the data under the auspices of the USGS has begun. The data is expected to be collected and posted for the foreseeable future, and will be a resource useful in assuring the long-term maintenance and protection of water resources in the region.

Background

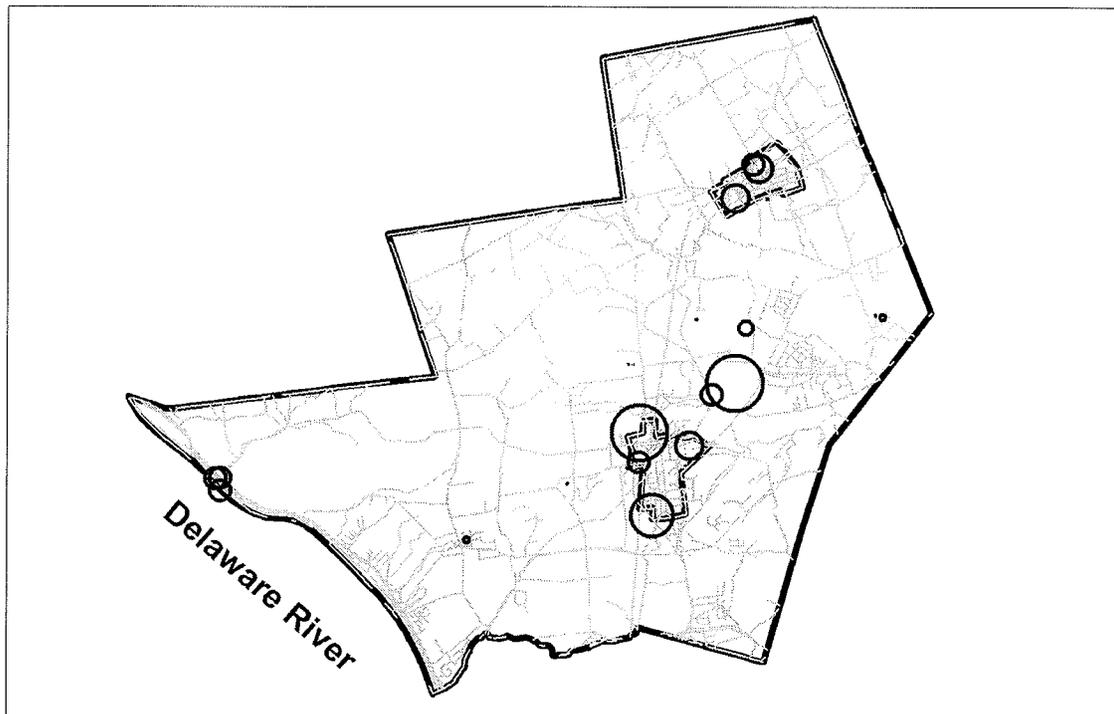
Protection of water resources is a high priority in Hopewell Township. The water resources of the region have been found to be challenged by relatively limited recharge, with current uses potentially approaching the limits of sustainability regarding both water quality and quantity.¹ Several public and industrial supply wells withdraw groundwater in the Township, and evidence exists that withdrawals from Pennington Borough's public-supply wells have lowered water levels in nearby domestic wells in Hopewell Township. However, the possibility that these groundwater withdrawals are causing a long-term measurable effect on water levels in private wells has not been proven, and a recent report of a dramatic decline of water level in a private well near Pennington² has been found to be in error, with the apparent decline due in fact to instrumental drift; proper calibration of the instrument showed that the declines were illusory.³ Nevertheless, numerous anecdotal accounts exist of water level declines in area wells, and a 1993 study⁴ reported evidence of interference with nearby domestic wells from Pennington public water supply wells.

Concern also exists regarding stream base flows. Some data suggest that base flows of at least two area streams, the Neshanic River and the Stony Brook, have in fact declined over the last several decades. A recent report⁵ compared recent periods of low flow in these streams with the flows during the "drought of record." Regarding the Stony Brook, this report states, "The low flows achieved in 1963 after two consecutive years of below normal precipitation were again achieved in 1999 after a few months of dry weather. If the wastewater component were removed from the streamflow data for this river, it is highly probable that baseflow during the recent droughts would be significantly less than during the more severe 1960s drought." The report also compared recent flows in the Neshanic River during dry periods and found these flows less than in the drought of record in the 1960s, despite the more severe drought conditions then. It concluded that, "The 1999 and 2001/2002 data in comparison to the "Drought of Record" data indicate that as a result of upstream changes to the Neshanic River system and increased groundwater demands within this basin, shallow subsurface sources are quickly dewatered and the deeper aquifer systems are no longer capable of providing baseflow to this stream."

Existing water withdrawals include those of the many residents of Hopewell Township using private wells, and also include a number of relatively large public wells. (Figure 1.) The possibility that water quantity, as reflected in stream flows and aquifer levels, is already impacted by

development, and the vulnerability of the region's waters to future impact, indicates a need for careful and reliable monitoring of water resources. Needed is a groundwater monitoring and stream flow monitoring program that can be continued for the foreseeable future and provide data to support rational decision-making regarding water resources. The program should complement existing monitoring efforts, and together with these efforts, should be extensive enough to provide a reasonably comprehensive picture of the water resources quantity in the region, including being able to show any long-term trends that may develop. The data provided by this program should be quality controlled and entered into a database that is readily available to the public; ideally via the Internet.

Figure 1. Public and Commercial/Industrial Pumping Wells in the Hopewell Township Region
Size of circle represents relative water withdrawal quantity



Project Design

In an effort to meet the need for additional monitoring, the current project was initiated. The first step was the identification of existing monitoring efforts in the region. These included four observation wells in Hopewell Township monitored by the USGS (Figure 2). These wells are significant resources for continuous evaluation of ground water levels. However, they constitute neither a complete nor a comprehensive water resource monitoring network for Hopewell Township, in part because they are not close to the areas of greatest ground-water withdrawals. Groundwater levels are also collected at a private well (subject to errors introduced by use of the well for domestic supply) west of Pennington Borough by Hill Environmental, Inc. Data from this well have been collected since 1997 pursuant to an NJDEP water allocation permit held by Pennington Borough. Records from this well appeared to indicate a decline, but were found to be in error as noted above. Further, as a continuously operated domestic supply well, this well is subject to errors that dedicated monitoring wells are not. Nevertheless, this well continues to provide important data. There are also several groundwater observation wells in operation on the Bristol-

Myers Squibb, Inc. (BMS) property east of Pennington Borough that were installed and for which data are reported to the Township pursuant to a Developer's Agreement between the Township and BMS. In addition, Pennington Borough, Hopewell Borough, and BMS report static levels in their supply wells to the NJDEP quarterly pursuant to their water allocation permits. The data described above are collected and reported in varied formats by different entities with different QA/QC standards. Other than a twice yearly recording of stream flow in the Stony Brook carried out by a facility in the Township, Bristol-Myers Squibb, no stream flow monitoring was in place.

In reviewing the data available through these existing monitoring efforts, a group of groundwater experts convened by the Township's Environmental Commission recommended that data from existing monitoring be quality controlled, collated, and summarized in a uniform manner.⁶ The experts also proposed additional data be collected in regions of importance that are not effectively monitored by the existing network. Surface water monitoring was also identified as necessary for a comprehensive picture of the status and trends in water supply in the Hopewell Township region.

It was decided to initiate ground water level monitoring at three additional sites in the Township. Two of these were existing unused wells that had been installed earlier in connection with land development plans that were not realized. A third well was drilled at a spot at the side of Scotch Road, in the vicinity of locations where, according to some anecdotal reports, water levels had already dropped. This site was judged likely to have the potential to show the effects of groundwater withdrawals from Pennington's public supply wells.

It was further decided to install nine low flow stream gauges consisting of stainless steel V-shaped weirs positioned at the center of low dams at stream locations in the Township judged to be both accessible and representative of the region's surface water flow.

Work Completed

The USGS, through an agreement with the Township that included the involvement of Township resident and USGS hydrologist Glen Carleton, was selected to be formally responsible for project oversight, data quality control, and data management and dissemination.

Supported by a grant from the Delaware River Greenway Partnership and the National Park Service through the National Wild and Scenic River Management Program obtained in September, 2006, and with matching funds and a commitment of in-kind services from Hopewell Township, work commenced in spring 2007.

A new water level observation well was installed at the Scotch Road location above. Three automatic data loggers, Design Analysis model DH-21, were then purchased and installed in this well and the two previously-existing wells. In summer 2008, nine stainless steel V-notch weirs were fashioned by a contractor according to specifications provided by the USGS. In late summer and fall of 2008, under the supervision of Mr. Carleton and with the involvement of a team consisting of numerous volunteers including representatives of the Township's Environmental Commission, Troop 1776 of the Boy Scouts of America, and Township employees, seven weirs, constructed of concrete with the V-notch weirs at the center, were installed. Since these were installed under the supervision of the USGS, they were approved through permit-by-rule provisions of New Jersey Department of Environmental Protection rules, and no specific permits were required.

Three are totally complete and consist of concrete walls approximately 16 inches high, 12 inches deep and the width of the stream, reinforced with steel reinforcing bars, with a stainless-steel V-

notch weir plate embedded at approximately the center of the concrete wall. Four are complete except for sealing of PVC bypass pipes through the walls that will be done in 2009 when water levels are low. Two more weirs are in preliminary stages of construction. All nine weirs will be completed by the same team in 2009, with any needed additional funding to be provided by the Township.

Locations and descriptions of the sites of the three new groundwater monitoring wells and of the nine weirs are provided in Table 1. Locations of existing and new monitoring wells and new stream flow gauges are pictured in Figure 2.

Data from the wells is now recorded with the automatic data loggers, which consist of water-level measuring transducers connected to a data storage system. Data are recorded hourly, quality controlled/quality assured with methods that include periodic calibration by USGS personnel, averaged to daily, and stored in the USGS national database. Data will be available on the internet at: <http://WaterData.USGS.gov/NJ/nwis>

Stream flow will be measured during base flow conditions (that is, at least 3 to 5 days since the last precipitation or snow-melt event). When a sufficient number of measurements (about 10 or more) have been made, the flow in the stream can be statistically correlated to continuously-recorded flow at nearby USGS gauging stations allowing flow statistics (e.g. mean annual flow, mean annual baseflow) to be calculated. Stream discharge will be divided by watershed drainage area to determine discharge per square mile of basin area. Estimates of flow characteristics relative to different rock formations can be made by comparing discharge per square mile of different basins.

**Figure 2. Existing (USGS) and New Monitoring Sites in Hopewell Township
(New sites all installed with this project)**

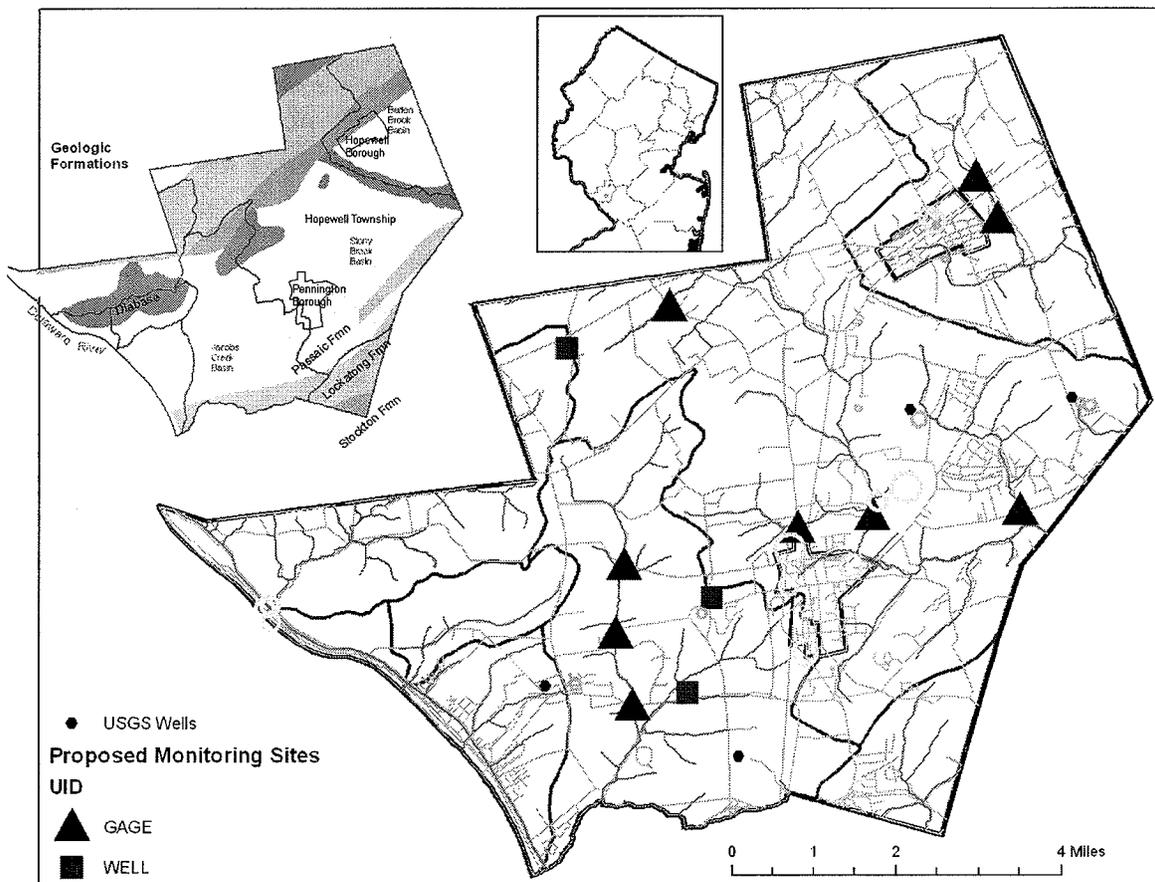


Table 1. Site locations, descriptions, and important aspects

Site	Type	Description and Important Aspects
Scotch Rd., E. side, ~100 meters N. of Delaware Ave.	well	Location along geologic strike from Pennington Borough's supply well 9, in Passaic geologic formation (Brunswick shale). Location believed to intercept some of the same bedding planes as this municipal well, and is near residential wells that have been deepened in response to supply problems. Well is 150 feet deep, has 50 feet of casing; yield was 15 gpm for 2 hour test period. Static water levels in 2008 ranged from 75 to 88 feet below grade; Located near stream basin divide, likely to experience larger water-level fluctuations than a well closer to a stream.
FOHVOS preserved property (Gomez tract), E. side of Harbourton-Rocktown Rd., near Lynnbrook Dr.	well	Location is in Lockatong formation; no other known monitoring wells in the region are in this formation. Well is cased to 50 feet, open hole to 200 feet. Static water levels in 2008 ranged from 37 to 43 feet below grade. Located near stream basin divide, likely to experience larger water-level fluctuations than a well closer to a stream.
Hopewell Township property (Alliger tract), N. side of Rt. 546, between Jacobs Creek Rd. & Scotch Rd.	well	Location is between two existing USGS wells and the region of concern west of Pennington. Well is cased to 50 feet, open hole to 200 feet. Static water levels in 2008 ranged from 37 to 40 feet below grade. Located between the upper reaches of two small streams, the well is likely to experience smaller water-level fluctuations than wells located at basin divides.
Jacobs Creek, bridge at Rt. 546 (Washington Crossing-Pennington Rd.)	weir	Location is ~3 miles (14,100 feet) above the confluence with the Delaware River. The reach of the creek between this site and next upstream site is subject to impact from a nearby water supply well that serves a 104-home development. Comparison of measurements at the two sites could show effect of the groundwater withdrawal on streamflow. The USGS made 24 flow measurements at this location from 2002 to 2008 and the USGS/NJDEP collected 5 water quality samples from 1998 to 1999.
Jacobs Creek, bridge at Pennington-Titusville Rd.	weir	Located ~1 mile (5,300 feet) above the Rt. 546 weir. See description of downstream site, above. The USGS made 6 flow measurements at this location from 1984 to 1987, and 2 measurements in 2008.
Jacobs Creek, bridge at Pennington-Harbourton Rd.	weir	Located ~1 mile (4,500 feet) above Pennington-Titusville Rd. weir. Location is near relatively few homes and should provide background measurement for comparison with the other two Jacobs Creek sites (see above). Comparison of flow rates (and flow rates per square mile of basin area) between the two creek reaches measured by the Jacobs Creek weirs is expected to provide data on the degree to which stream flow in the Passaic formation is affected by nearby groundwater withdrawals. The USGS made 6 flow measurements at this location from 1984-1987 and 2 measurements in 2008

Table 1., cont'd. Site locations, descriptions, and important aspects

Bedens Brook tributary, private bridge, W. of Hopewell-Amwell Rd., ~0.6 mi. N. of Rt. 518	weir	Location is 0.6 miles (3,200 feet) upstream of Rt. 518 (see below site)The contributing area is underlain by the Stockton and Lockatong formations and is just upstream of where the Hopewell Fault crosses the stream and, therefore, upstream of the area affected by ground-water withdrawals by Hopewell Borough. The USGS made 4 flow measurements from 1984 to 1988 and 2 measurements in 2008. The USGS collected 2 water quality samples from 1987 to 1988.
Bedens Brook tributary, bridge at Rt. 518	weir	Location is downstream of where the Hopewell Fault crosses the stream and, therefore, downstream of the area affected by ground-water withdrawals by Hopewell Borough. The USGS made 1 flow measurement in 1965, 3 measurements from 1984 to 1987, and 2 measurements in 2008.
Baldwin Creek, below bridge at Rt. 31, near Old Main Street.	weir	Location is upstream of area influenced ground-water withdrawals by Pennington Borough. The contributing area is underlain primarily by the Passaic Formation and is in an area of low to moderate density of mixed land use (residential, farming, commercial). The USGS collected 48 peak streamflow measurements from 1957 to 2006 and 72 flow measurements from 1957 to 2008.
Baldwin Creek, below Baldwin Lake dam	weir	Location is 0.6 miles (3,100 feet) downstream of Rt. 31 (see above site) and 300 feet upstream of the confluence with Stony Brook. Site is downstream of the area on this stream influenced by ground-water withdrawals by Pennington Borough and, possibly, also is affected by large withdrawals by an industrial user located on the far side of Stony Brook. The USGS collected continuous stream flow data from 1962 to 1970, 6 flow measurements from 1984 to 1987, and 1 measurement in 2008, The USGS collected 115 water quality measurements from 1962 to 1970.
Honey Branch, below Honey Lake, ~ ¼ mile N. of Elm Ridge Rd.	weir	Location is downstream of a sediment-containment pond and long-established, moderate density housing development, will be good for comparison to sites in pristine areas. USGS made 12 peak streamflow measurements from 1967 to 1978, 36 flow measurements from 1957 to 1988, 1 measurement in 2002, and 2 measurements in 2008. The USGS collected 24 water quality samples from 1968 to 1988.
Woodsville Brook, bridge at Rt. 612	weir	Location is in area underlain solely by the Lockatong Formation, believed to be a low recharge (and, therefore, low stream base flow) area. The USGS made 19 peak streamflow measurements from 1957 to 1980, 37 flow measurements from 1957 to 1980, 1 measurement in 2002, and 2 measurements in 2008. The USGS collected 11 suspended sediment samples in 1970.

(FOHVOS = Friends of Hopewell Valley Open Space)

(The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government, the Delaware River Greenway Partnership, or Hopewell Township)

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² Hill Environmental Group, Inc., 2004, *Discussion of Groundwater Issues Associated with the Athletic Fields at Timberlane Middle School*, Hill Environmental Group, Inc., 19 Brookside Ave., Pennington, NJ 08534-9998

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⁴ Boyle, James T., 1993, *Well Interference and Evidence of Fracture Flow in the Passaic Formation near Pennington, Mercer County, New Jersey*, New Jersey Geological Survey, Open File Report OFR 93-1, New Jersey Department of Environmental Protection, Trenton, NJ

⁵ M² Associates, Inc., and Demicco and Associates, Inc., 2004, *Evaluation of Groundwater Resources of the Sourland Mountain Region of Central New Jersey*, prepared for Sourland Smart Growth Project, <http://www.sourland.org/planning/groundwater.pdf>

⁶ These experts included hydrogeologists Glen Carleton (USGS), Anthony Bonasera, Township Hydrogeologist Matthew Mulhall, Township Health Officer Gary Gaurino, and Rutgers University geologist Dr. Kenneth Miller